DOCUMENT RESUME

ED 206 045 EA 013 763

AUTHOR Nucci, Larry P.; Walberg, Herbert J.
TITLE Psychological Models of Educational Growth.
INSTITUTION Illinois Univ., Chicago. Chicago Circle Campus.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
PUB DATE 80
GRANT NIE-678-0090
NOTE 55p.; Paper presented at the Annual Meeting of the American Educational Research Association (Boston, MA, April 7-11, 1980). Some figures may be marginally legible. This document is Part I of a compilation entitled "Generalized Theory of Design and Analysis of Educational-Effectiveness Research." For related documents, see EA 013 759-761, EA 013 764-767, ED 168 714, ED 185 064, and EJ 210 984.

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Cognitive Development; Cognitive Measurement; *Developmental Stages; Diagrams; Epistemology; *Models; *Psychometrics
IDENTIFIERS Cognitive Structures; Erikson (Erik); Freud (Sigmund); Neo Piagetian Theory; Piaget (Jean)

ABSTRACT

A discussion of models of intellectual development and their application to education identifies the two major groups of such models and examines recent attempts to combine them. The two types of theories are described as the psychometric models, which see intellectual growth as the incremental amassing and associating of discrete ideas, and the structuralist or growth stage models, which view growth as a "stage-wise" series of qualitative transformations or reorganizations of the intellectual and affective processes. The authors first review the psychometric models, noting their orientation toward tests of vocabulary and other abilities as well as their lack of a theory of growth. The paper then considers the insights and problems produced by the growth stage models. It touches on the functional-descriptive models of Gesell and Havighurst, the psychoanalytic stage models of Freud and Erikson, and Piaget's cognitive development model. The paper's final sections discuss recent attempts to reconcile psychometric models with the cognitive development theory, including structural behavioralism and neo-Piagetian theory. These recent theories, observe the authors, may offer new ways to apply development theory to education. (RW)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
✓ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

ED206045

Psychological Models of Educational Growth

Larry P. Nucci and Herbert J. Walberg

University of Illinois at Chicago Circle

EA 013 763

AERA Presentation, 1980

John Dewey (1938) emphasized growth as the goal of education; and most educators today would support the value of promoting educational growth. Yet, researchers have made small and fitful progress in defining and measuring growth, and in plotting its trajectory during the school years. Only by having reliable absolute measures calibrated for growth, and a clear picture of the normal course of individual growth in a given environment is it possible to estimate the dependencies of accelerations in growth on given processes of teaching.

One major obstacle impeding the definition of educational growth is the current status of the science of education in what Kuhn (1970) refers to as a transition period. In its present transitional state, education is without a predominant paradigm. Instead several paradigms (borrowed from psychology, and espitemology) exist side by side that attempt to explain the same or related phenomena, each with its own set of assumptions, and concomitant definitions of growth.

This chapter discusses those models of intellectual and affective growth with greatest relevance to education, points out the relative strengths and weaknesses of each model and describes some recent attempts to formulate general growth paradigms that treat prior models as special cases.

The first two major sections of this chapter discuss 20th century views of educational growth; but many of these were clearly anticipated by Plato and Aristotle, were re-discovered and amplified by many Western philosophers and psychologists and deserve at least brief mention for historical perspective. See Riegel (1972) on the historical evolution of psychological conceptions of growth and development and Walberg (1975) on educational applications of developmental theories for greater detail and references to pre-

20th century theories.

The continental European tradition of psychological structuralism includes Descartes, Leibnitz, Hegel, Rousseau, Kant, Pestalozzi, Froebel, Montessori, Freud, Spranger, and Piaget and derives from Socrates and Plato whose mind-matter dualistic theory of education portrayed the teacher as "midwife of ideas" inherent in the child's mind. The tradition emphasizes the uniqueness of the child and qualitative stages of psychic growth. It has often led to educational applications that are child-centered or child directed in varying degrees and forms; Rousseau's romantic idea of the child's inherent savage nobility is one extreme of the tradition. From the continental perspective, the child's educational progress is less a function of individual needs, innately determined development; the structuring, integration, and stage-wise transformation of knowledge (rather than the accumulation of discrete elements) are stressed.

The Anglo-American tradition includes Hobbes, Locke, Darwin, Spencer, Sumner, Pearson, Galton, Hall, Thorndike, Gesell, and Terman and derives from Aristotle's notion of learning as the association of discrete ideas. Atomism, both mental and behavioral, is a dominant psychological idea in England, the United States, and other English-speaking nations. The Anglo-American model of mental growth assumes the steady amassing of knowledge rather than stage-wise re-organizations. As represented in the work of Thorndike and Terman, educational applications of atomistic theory include curricular materials divided into units and discrete elements and continuous indexes of growth indicated by sums of items answered correctly on multiple-choice, psychometric tests. The Anglo-American educational psychologist characteristically employs statistical analysis of cross-sectional psychometric data on large numbers of students or of closely manipulated, controlled

experiments, whereas Continental psychologists typically employ intensive, longitudinal case studies of one or a few children.

The division of psychology by the English channel is obviously oversimplified; both continental and Anglo-American psychologists are aware of the two traditions and draw on both of them. Nonetheless, the intellectual gap between them in its philosophical, scientific and pedagogical aspects persists and causes misunderstandings among educational theorists and practitioners. Our discussion of 20th century research starts with the atomistic tradition because it will be more familiar. But more attention will be given to stage models because they currently offer an interesting challenge to American psychologists and educators. In the last section, several recent models are presented that attempt to bridge the gap between the two traditions.

Psychometric Models

Empirical research on educational effects since 1950 has been mainly based on the two mainstreams of educational psychology - behaviorism and psychometrics, which have been characterized as atheoretical by two of their leading contributors (Skinner, 1957; Lumsden, 1976). Behaviorism carries with it a characteristic methodological concern with experimental isolation of short-term discrete observables rather than long-term developmental processes in natural settings. In the cognitive domain, psychometrics in education usually concerns atomistic items of verbal knowledge as revealed by internally-consistent, multiple-choice, paper-and-pencil tests. Thus much of the research on teaching effects is an attempt to correlate student gains on multiple-choice tests of knowledge to observed and counted acts of teaching.

Few psychometric studies have been conducted on children tested repeatedly throughout the school years; and, in the main, they concern vocabulary,

general verbal intelligence, and special abilities rather than achievement in the usual school subjects. Nearly all suffer from one or more methodological problems: cross-sectional data; small, unrepresentative samples; unreliable measures; and limitations in analysis. Nevertheless, it is far easier to criticize such studies than to do them well; moreover there is much to learn from them, and they may anticipate what will be found with more adequate research methods.

It may be recalled that Binet and Simon (1916), turn-of-the-century French founders of mental measurement, sought to devise and select intelligence test items for a given age upon which about half the children would succeed. Items with either near-zero or near-complete success have little power to discriminate among students, and, being out of the appropriate age range, would be too easy or too difficult for efficient measurement of individual differences. Since Binet, educational measurement, as it is taught and used, concerns such normative or relative comparisons of individuals of the same age or grade rather than the absolute growth of single individuals over time. The pervasive technique may be likened to using a different and relative scale to measure height at each year of age, which would encourage statements as "Tom was at the 65th percentile at age 10 and the 55th at age 13" instead of concrete expressions of absolute growth as "Tom grew two inches in three years" or metric relations such as "an average protein deficiency of 40 grams per day is associated with growth deficit of .15 meter in height over a given age range".

Normative or relative measurement is seldom used in the natural sciences; and one of the main impediments to behavioral theory and research in natural settings is the lack of absolute measures. Coaching and physical training offer the best examples of teaching most feasible for productivity research

because absolute measures such as time and distance may be used. Thus it is possible to observe in competitive swim coaching that many laps at moderate rate lead to fast times for endurance swims such as the 1500 meter; and moderate numbers of fast laps with short rests lead to fast sprint times (Counsilman, 1968). Gains in academic teaching efficiency since 1900 might be difficult to prove, but coaching for athletic competition has made steady progress in breaking records decade after decade, partially no doubt because of the availability of absolute measures of independent and dependent variables, even without true experimentation. Random manipulation of the independent variables in coaching many sports permits accurate forecasts of the multiple outcomes of any regimen for an individial, or given a desired set of outcomes, to pick the best regimen. The analytic work of Thurstone (1921), Gardner (1950), Bock (1975), and Wright (1977) on absolute psychometric scaling holds out the possibility of comparable precision in the area of academic growth.

Investigators have estimated vocabulary growth more often than any other cognitive measure (see Dale's, 1965, review) perhaps because the number of words known may be estimated; and most aptitude and achievement tests are saturated, that is, correlate highly, with vocabulary. Nonetheless, the estimation of vocabulary is fraught with methodological difficulty (see Lorge and Chall, 1963). Estimates of vocabulary for a given grade or age group can vary by a factor of ten depending on: the sample; what is meant by knowing a word, for example, pronouncing it, selecting the correct definition from a list, or recalling it from memory; whether multiple meanings of words are considered; and other factors.

Smtih's (1941) study, one of the most extensive in the literature, produced smoothed estimates of vocabulary for grades two through twelve. Smith's estimates of the 25th, 50th (median), and 75th quartiles suggest de-

celeration, and acceleration (Figure 1).

Insert Figure 1 about here

However, dropouts in the high school years leaving a more select group may account for the late acceleration in these cross sectional data. Dalé (1965) estimates that children on the average finish first grade with a vocabulary of 3,000 words and add linearly 1,000 words a year through the fourth year of college. Smith's and Dale's estimates of 12th grade vocabulary, 60,000 versus 14,000 words, and projections of the growth curve, re-accelerating versus linear, differ sharply. The discrepancies may be attributable to cross-sectional, aggregate data (see below).

Thurstone's (1929) cross-sectional estimates of Binet intelligence of 4,208 children ages 3 through 17 covers a wider age span than most vocabulary studies and suggests logistic growth (Figure 2). Bayley's analysis of longitudinal data from three studies, however, suggests rapid linear growth in intelligence from birth through the school years til about age 19 and slow growth thereafter (Figure 3).

Insert Figures 2 and 3 about here

One problem with all the estimates of cognitive growth discussed thus far is that they are based on grade or age group means. As Bock (1975) points out, biologists have long known from physical growth studies that means obscure the actual growth curve of individuals. The plot of height by month of a single individual during adolescence usually shows a sharp growth spurt at a certain period. But the onset of the period will vary considerably among individuals; and a plot of means of age groups will be far more regu-

lar and gradual than for any individual (Merrell, 1931; Batschelet, 1976). Bock's analysis of longitudinal growth in verbal ability of 36 boys and 28 girls in a laboratory school during three years from grade 8 to 11 shows that only linear growth can be detected for any individual. Yet a decelerating trend of means by grade is highly significant. Thus the precision and regularity of averaging reveals the decelerating trend, but the tests, though technically good by the usual standards and reliable for measuring differences among individuals and linear and quadratic growth of the group, are too unrealible to measure any curvature or other departure from linear growth for a single individual. Indeed, in a recent interview, Linn and Slinde (1977) conclude that even difference scores for individuals from a pre-test to a post-test are too unreliable to warrant calculation and interpretation.

If agronomists had been unable to relate yield or value added to amount of irrigation, rainfall, and fertilizer, agricultural productivity would be far lower than it is. Before considering the measures of educational yield that seem necessary, compositional or allometric growth should be considered.

If measurements of two parts of an organism, say the lengths of the infant's head and the rest of the body, are taken a various points during the life span or cycle, very often the plot of points forms one of the simple curves in Figure 4 and can be well fitted by only two constants. As von Bertalanffy (1968) points out, it is astonishing that, in view of the great complexity of growth processes, a simple equation (given in the note to Figure 4) fits a wide range of morphological, biochemical, physiological, and phylogenetic data and accounts strictly (aside from measurement error) for linear and exponential growth of parts and approximately for the more complex cases of logistic, parabolic, and Gompertz growth.

Insert Figure 4 about here

Thurstone's (1955) analysis of multiple mental abilities of a cross-sectional sample of large numbers of children ages 5 to 19 is apparently the only study that fits the growth of multiple mental measurements over the years of schooling to theoretical equations. Thurstone's estimated absolute scores on the Primary Mental Abilities tests fit Gompertz equations, (similar to logistic growth) reasonably well (Figure 5). Thus growth of these specific measures relative to one another, approximates allometry over the school years

---

Insert Figure 5 about here

---

and follows allometry more exactly on either side of the inflection points. Such aggregate, cross-sectional allometry may poorly estimate longitudinal-compositional growth of individuals, and it is the only quantitatively-fitted estimate available. Thus our understanding of total and compositional mental growth of individuals is severely limited by the dearth of absolute measures on individuals over decades of time.

Implications

Unlike biology and economics, educational research has no theory of growth; and despite three quarters of a century of effort, cognitive measures are insufficiently reliable to trace accurately the growth trajectory of vocabulary, general intelligence, special abilities, and school achievement among individuals. Only by having reliable absolute measures calibrated for growth throughout the school years and a clear picture of the normal course of individual growth in a given environment will it be possible to estimate replicably and accurately departures from natural growth curves; more specifically, the dependencies of acceleration in growth on given educational processes.

Successfully or not, school staff in recent decades attempted to tailor instruction to individual needs instead of using the compromise of factors that would presumably suit the hypothetical median student. Wright (1977) suggest several ways that testing might also be tailored in this way. For example, a booklet of test items of ordered difficulty can be designed so that the student can rapidly find the sequence of moderately challenging items that provide the most reliable estimate of his ability in a minimum amount of time; extensions of the Rasch model permit the accurate calibration of items and tests for reliable individual growth measurement (Wright, 1977). Moreover, Bock (1975) has adapted the mathematical theory of logistic biological growth for educational research and shown how to estimate growth of individuals from their responses to items of heterogeneous difficulty.

To conclude this section, it may be speculated that one pre-condition for a warranted theory of educational productivity is an adequate theory and measure of student growth. Such a contention follows analogous historical reasoning from biology, economics, and their applications in agriculture and investment that required for their theoretical development explicit models of growth and measures of increased yield. The same contention may also be argued on the grounds of operational definition: if the theory of education must specify the quantitative constants of the dependencies of learning on educational processes, then reliable measures of absolute growth and its acceleration are required to estimate the constants accurately and replicably. Biology provides growth curves and equations that seem good bets for probing in educational research. It seems more our in-grained habits of normative conception and measurement than theoretical or technological obstacles that prevents such probing.

Stage Models

Unlike the psychometric models that assume steady growth, a number of accounts of cognitive and affective growth portray development as a series of qualitative transformations or stages. Common to all stage models is the assumption that each stage represents a point of discontinuity with past ways of organizing information, or interacting with the environment. Another assumption common to these models is that the sequence of transformations of growth stages is invariant in the sense that more advanced levels can never precede more primitive levels. Beyond these points of commonality, however, stage models can be divided into different types in terms of (a) their assumptions regarding the mechanism of stage change, and (b) their definitions of the structure and content of the growth sequence. In this review we will look at three types of stage models: functional-descriptive, psychoanalytic, and cognitive-developmental. Throughout our discussion we will refer to Table 1, which presents a sketch of the stage-sequences offered by the various growth models.

Insert Table 1 about here

Functional-Descriptive Growth Models

What we classify as functional-descriptive growth models are systems which focus on the definition of what is typical of a person at a given age, and/or the nature of developmental tasks associated with a given age with less concern regarding the mechanisms or processes which underly the transformations from one point in development to another. Two such models have had important influences on educational practice in this century and thus deserve our attention: Gesell's growth stages, and Havighurst's sequence of developmental tasks.

A. Gesell's Approach

The notion of sequential levels of growth as an important idea for educators first gained prominence when proposed by Arnold Gesell in the 1930's. By observing and recording a wide range of physical and behavioral features at successive ages Gesell (1925, 1928) defined a sequence of age norms which he generalized as a set of universal stages (Bayley, 1970). Each stage, which is equivalent to the characteristics of a given age, is believed to represent the child as a total organism. From this proposal sprang such descriptiors as the "terrible twos, terrific threes, etc."

Gesell's approach has been criticized in recent years for the circularity of ascribing behavior to a stage merely because the behavior typically appears at a given age (Achenbach, 1978) and for failing to demonstrate the inter-relationship among the various aspects presumed to define a given stage (Ginsburg & Opper, 1969). Nonetheless, Gesell's notion of the sequential emergence of various competencies has had great influence on notions of school readiness. Recently researchers at the Gesell Institute (Ilg & Ames, 1965; Ames & Ilg, 1964) have re-established the age-norms and proffer a set of school readiness tests intended to determine overall readiness rather than a single index of intellectual development (e.g. I.Q.). Kaufman and Kaufman (1972) determined that the battery of Gesell measures taken at kindergarten correlated moderately with first grade school achievement (r .56 - .64 as measured with the Stanford Achievement Test). This predictive validity was higher than that for a standardized group intelligence test. However, the utility of the proposed "whole organism" view of growth is challenged by findings of near zero predictive validity of general maturational growth measures such as teething. A possibility unresolved by the Kaufman and Kaufman study is that the success of the Gesell Institute battery as a measure of school readiness may well be mediated by the kinds of cognitive changes

described by Piaget. We will discuss Piaget's model later in this chapter.

B. Havighurst's Developmental Tasks

A second functional-descriptive model to have had impact on educational practice is Havighurst's (1948, 1953) sequence of developmental tasks. In Havighurst's model individual development is defined as a series of developmental tasks each of which must be dealt with successfully at the proper time in order for later achievement to occur. Examples of developmental tasks at the elementary grade level include such things as learning to get along with age-mates, learning an appropriate masculine or feminine role, developing fundamental skills in reading, writing and calculating; at the secondary grade level the tasks include achieving emotional independence of parents and other adults, selecting and preparing for an occupation, and preparing for marriage and family life. Accordingly, Havighurst defines the purpose of education as to help the student achieve his developmental tasks in a personally and socially satisfactory way. Consistent with this aim, Havighurst integrates his view of the developmental task with the notion of "the teachable moment" (Havighurst, 1948, 1953) or critical period in which the learning of the role or task achievement should occur. For example, Havighurst (1964) proposes that adolescence is the really critical period for vocational decision making (see Table 1).

Havighurst's developmental progression offers an insightful descriptive analysis of age-typical events. His emphasis upon the normal, and his integration of social and emotional growth with both intellectual attainment, and practical life-task skills have made his description particularly appealing to educators put off by the overtones of pathology in psychoanalytic accounts, and the abstract nature of Piagetian descriptions of logical forms. However, Havighurst's model is seriously limited as a measure of educational growth. First, the assumption of critical periods of development

can be questioned. For example, recent research (McLaughlin, 1977; Snow and Hoefnagle-Hohle, 1978; Walberg, et. al., 1978) in the area of second-language acquisition, long thought to be a facility that diminishes with age (Lenneburg, 1967), has indicated that there is no critical period for second-language learning. Second, Havighurst's model catalogues a series of socio-cultural tasks which by definition are normative descriptions of age-related behaviors of a particular historical period for members of a given social-class, sex, ethnic group, or culture. Thus, Havighurst's progression cannot serve as an absolute measure of educational growth.

In summary, functional descriptive models offer educators a clear set of descriptions of age-typical behaviors which can be used as bench-marks of the student's progress toward maturity. However, because of the lack of emphasis on theory, these models do not adequately explain (a) how events in one stage are related to occurences in later stages, (b) why certain things appear together at given ages, and (c) how movement from stage to the next occurs. Thus, it becomes difficult for the educator to plan strategies which will insure that growth will occur. A final limit of many functional-descriptive models (as evidenced in Havighurst's approach) is the description of growth in terms of socio-cultural achievements; thus limiting the utility of a given model to a particular cultural group or historical period.

Psychoanalytic Stage Theories of Freud and Erikson

A. Freud's Psycho-sexual Stages

Development according to Freud is a progression of psycho-sexual stages in which movement from one level to the next is dictated by biological factors which regulate the shift of libidinal energy from one region of the body to another. Each shift results in a novel set of interactions with the environment made necessary by the individual's needs to find acceptable ways to

reduce the psychic tension associated with the libidinal urges of a given stage. As each stage is encountered concomitant personality structures are formed (see Table 1).. The form which the resolution of the problems of a given stage takes is greatly affected by environmental circumstance. Thus, though the sequence of stages is determined by maturation, the structure of the individual's psyche is unique.

The process of development, and the universal struggles attributed to each level are presumed to be responsible for qualitative shifts in the type of intellectual activity associated with various ages. Anna Freud (1936) links intellectual creativity or fervor, with various periods of psychosexual development. Preschool children, she writes, display a number of brilliant, and creative intellectual achievements as a result of prohibitions against their inquiries into the mysteries of sex, which cause them to redirect their questioning into other areas. Similarly, the adolescent seems brighter than younger children essentially owing to the enormous surge of libido at puberty. "Like a forest ranger who becomes more sharp sighted when he hears that there might be a fire in the area, his ego, responding to the increased instinctual pressures, expanded its powers of rationality"(Freud, 1936, p. 163). During the latency, or elementary school period, children according to Freud not only dare not indulge in abstract thought; they may have no need to do so. Infancy and puberty are periods of instinctual danger, and the intelligence which characterizes them serves at least in part to assist the individual to surmount that danger. In latency and adult life the ego is relatively strong and can without detriment to the individual "relax its efforts to intellectualize the instinctual process" (A. Freud, 1936, p.164).

Though attempting to explain a set of assumed age-related intellectual characteristics in terms of psycho-sexual development, Anne Freud does not offer any objective data of her own to support such a contention. For the

most part, Freudian educational psychologists focus their attention upon the relationship between the school environment and the psychodynamics of each stage as they relate to ego functioning and the development of the healthy personality. Educational productivity is viewed as a function of sublimated libidinal needs channeled through the reality function of the ego. Since maturation determines the sequence of developmental events, the role of environment hence education, is to foster the "healthy" or successful resolution of the problems presented at each age (Bettelheim, 1948; Ekstein & Motto, 1966; A. Freud, 1969).

Freud's account of development offers a positive contribution to education in that it moves the question of achievement away from the predominant emphasis upon cognitive mechanisms and brings into focus the relationship between emotional development and the overall aims of education. Second, the Freudian model offers education an absolute set of age-related variables with which to assess growth and development, and upon which to base intervention strategies. However, the emphasis on maturation makes it difficult to see how education can alter the rate of development or movement through disruptive periods.

Major criticisms of the theory attack the sexist aspects of the explanation of growth which define female psychosexual development in terms of lacks in male characteristics rather than in terms of female attributes. This particular criticism is important if such definitional flaws result in an innacurate assessment of female growth. While a number of contemporary analysts (e.g. Barglow, 1977) have attempted to address this issue, it is not clear that they have succeeded in demonstrating the efficacy of Freudian typology for assessing female psychosexual maturity.

A second set of criticisms focus on problems in measuring growth in terms of psychosexual level. One aspect of this problem is the vagueness and

complexity of psychoanalytic interpretations which make assessment of an individual's growth largely unreliable even among experts (Anastasi, 1976). Another measurement problem stems from the definition of growth stages in terms of a sequence of qualitatively differing attributes without defining the structural relationship bewteen later stages and the outcome of earlier stages. Thus as Loevinger (1966) points out, the measurement of psychosexual level means measurement of a whole series of things, at least one for each level, each to be measured in terms of muchness. Referring to Blum (1949), Loevinger (1966) reminds us that such judgments are notoriously difficult to make. A third, and perhaps damning critcism is the contention that Freudian theory with its emphasis upon unobservable intrapsychic events and post-hoc explanatory devices for observed behaviors (e.g. reaction formation: you say you don't agree with me because you do agree with me, but you don't want to admit to yourself that you do agree), renders itself untestable and hence not within the realm of scientific invetigation.

B. Erikson's Psycho-social Stages

While adhering to the basic tenets of Freudian doctrine, Erikson takes exception with Freud's accounts of ego development. Basing his position on Hartman's (1939) notions of "conflict-free ego", Erikson set out to study transformations of the ego as attempts through the "reality" or cognitive functions to place the self within a societal context while maintaining a sense of personal continuity or individual identity. Erikson's account of ego development may be viewed as relevant to attempts to chart the course of educational growth in two ways. First, the bi-polar sequence of transformations in ego structure (see Table 1) may be viewed as a description of potential socioemotional achievements which education may wish to foster. Second, the stages indicate potential periods of psychological stress which may portent

periods of disruption in the course of academic achievement.

Recent research within the Eriksonian framework has demonstrated that the stages proposed are age-related (Ciaccio, 1971), and have offered measures which can differentiate among the different forms of Identity vs. Role Diffusion (Stage 5) development (Constantinople, 1969; Dignan, 1963; Marcia, 1966). Use of these scales has demonstrated changes in ego-identity status over time (Marcia, 1976; Waterman & Goldman, 1976), and have shown relationships between ego-identity status and various behavioral and personality variables (Marcia, 1975; Marcia & Friedman, 1970; Orlofsky et.al, 1973; Waterman & Goldman, 1976). These studies lend support to Erikson's proposals of the stages as developmental, and offers the prospect that one may identify individual development with some precision.

Criticisms of Erikson's theory are centered, as was the case with criticism of Freud, upon the discrepancies between male and female development (Gallatin, 1975). The most disturbing of the observed discrepancies with regard to the veracity of Erikson's model are recent studies (Marcia & Friedman, 1970; Douvan & Adelson, 1966) indicating that within the constraints of traditional American society, the stage of Identity vs. Role Diffusion works only for male adolescents. Women either display types of identity formation inconsistent with the theory (Marcia & Freedman, 1970), skip the stage entirely proceeding directly from Industry vs. Inferiority to the stage of Intimacy vs. Isolation, or display the stage of Identity vs. Role Confusion after first going through the period of intimacy (Douvan & Adelson, 1966). Gallatin (1975) in her cogent analysis of these inconsistencies concludes that the theory's strongly biological orientation regarding the identity issue creates a problem for the theory as a whole. From her point of view, history

not anatomy is probably the central factor. She suggests that Erikson's description of the moratorium period is something of an ideal; a notion with acceptance in the twentieth century. Consistent with Gallatin's analysis are findings of a recent study (O'Connell, 1976) indicating that contemporary career women, who do not disrupt their careers when they have children, develop identity statuses essentially like men. These findings offer strong support for the contention that Erikson's stages represent a series of socio-cultural adjustments rather than a maturationally determined sequence. As such Erikson's model may be best understood as a sequence of age-typical, culturally relative developmental tasks much like the model proposed by Havighurst. Such a conclusion has been reached by Broughton (1975), Haan (1977), Kohlberg (1973) and Loevinger (1966). Thus Erikson's approach may suffer the same limitation as a model of educational growth we have attributed to the functional-descriptive growth sequences.

Piaget's Cognitive-Developmental Stage Theory

Most recent research on the relationship between developmental variables and education focuses upon or refers to cognitive developmental theory. The cognitive-developmental approach presented by Piaget shares a number of features in common with the stage theories already presented. That is, Piaget views intellectual growth as proceeding through an invariant sequence of qualitiative transformations in cognitive function organized as stages, rather than by the accumulation of knowledge or incremental quantitative shifts in intellectual capacity characterized by the psychometric approach discussed in the first section.

However, too much can be made of the communalities between Piagetian and other stage theories. Piaget's approach while recognizing the role of genetic and environmental factors in the process of intellectual growth, attributes

the emergence of cognitive structure to the individual's construction of meaning as a result of interacting with the environment rather than to the predetermined unfolding of cognitive structure as a process of maturation, or the acquisition of mental structures isomorphic to those of the culture. The Piagetian view is summarized in his four point definition of developmental stages:

> (1) Stages imply distinct or qualitative differences in person's modes of thinking or of solving the same problem.
>
> (2) These different modes of thought form an invariant sequence, order or succession in individual development. While cultural factors may speed up, slow down, or stop development, they do not change its sequence.
>
> (3) Each of these different and sequential modes of thought forms a "structural whole". A given stage-response on a task does not represent a specific response determined by knowledge and familiarity with that task or tasks similar to it; rather it represents an underlying thought-orientation.
>
> (4) Cognitive stages are hierarchical integrations. Succeeding stages re-integrate the structure of previous stages into increasingly differentiated and integrated forms of reasoning.
>
> ---Piaget, 1960

Four stages of development are defined. These are included in Table I along with their approximate ages of appearance.

The results of research examining Piaget's description of cognitive development, while largely supportive, have been mixed. Results from a series of cross-cultural studies (Bovet, 1974; Dasen, 1977) are consistent with the proposition that the sequence of stages is universal. In concert with those

results, a series of training studies (e.g. Inhelder et. al, 1974; Kamii & Derman, 1971; Smedslund, 1961) provided evidence that movement from one stage to the next does not occur as a simple function of direct instruction (for more complete reviews see Mogdil, 1974; Strauss, 1972, 1973). Studies by Kuhn (1972), Strauss and Liberman (1974), Strauss, et. al, (1977) and Turiel (1966, 1974) have provided empirical support for the proposal that structural regressions do not occur; thus supporting the proposal that stages progress unidirectionally through a process of transformation and reorganization. Finally, the proposal that development occurs through a series of discrete qualitative transformations rather than an incremental, cumulative process is supported by a recent study (Neimark, 1977) demonstrating that qualitative shifts in problem solving strategy are associated with marked rather than incremental changes in the quantity (bits) of information obtained.

Challenges to Piaget's theory come from several sources (see Brown & Desfarges, 1977 for a thorough discussion). However, two issues are of central concern: (a) the internal consistency of stages, and (b) the nature of stage change. With regard to the first issue a number of studies have reported moderate correlations between individual's performance on separate tasks said to measure the same cognitive operation. Typically, these correlations are about .40 (Brown & Desfarges, 1977). Piagetians explain these findings as illustrating the existence of horizontal decalage (temporal lag in the ability to generalize a given form of logic from one task to another, e.g., the ability to conserve quantity, but not amount). However, it is necessary that the extent of decalage not overwhelm the examples of internal consistency if the stage notion is to have any utility. Recently, Piaget (1968) has offered a clarification of his notion of structure which raises a number of interesing possibilities. In sum, Piaget has made clear that his notion of structure is not intended to suggest that everything is connected

with everything else, *but rather that knowledge is constructed within* "partial structures" which interact with one another to form one's total system of thought. This hypothesis has received expression in recent research and theory in social cognition (Nucci, 1977; Nucci & Turiel, 1978; Turiel, 1975, 1978, 1979) indicating that various aspects of social reasoning are constructed within distinct conceptual and developmental domains (see Gordon's chapter in this volume for further discussion). In addition, recent work on formal reasoning (Piaget's fourth stage) may be viewed as attempts to define partial structures by means of factor analysis (Bart, 1971), and through more general correlational approaches (Neimark, 1970, 1975). While this research offers a possible resolution of the problems associated with defining cognitive structure, the possibility also exists that the research instead will demonstrate that the "cognitive pie", so to speak, can be divided up any number of ways thus refuting the notion of cognitive structures, and the concomitant stage theory.

The second major issue, the nature of stage change, is equally controversial. A main strength of Piagetian theory as a model of intellectual growth is its inclusion of an explanation by which earlier stages are transformed by the individual into more advanced ways of thinking. However, one limit to the ready acceptance of Piaget's paradigm as a model of intellectual growth is the apparent lack of specificity regarding the steps individuals take in moving from one level to the next. Genevan researchers (e.g., Cellerier, 1972) recognizing this deficiency have recently begun attempts to trace the changes from one level to the next by incorporating aspects of information processing theory into the Piagetian framework. Parallel developments have taken place in this country in which researchers have attempted to outline the intervening rules or strategies employed in moving from one level to the next. Some of

these attempts will be discussed in the next section of this chapter. One potential outcome of this research would be to resolve the apparent incompatibility between incremental and stage descriptions of intellectual growth.

Related to issues of theory are concerns with the process of measuring developmental level. At the present time, most attempts to place stages into an assessment framework have employed some form of a simplex scale (Guttman, 1955). Such measurement is based on the notion that a person is capable of passing all items at and below his/her developmental level, and not those items which are above that level. A variant on this type of scaling has been used by Kohlberg (1969) as a demonstration of the validity of his moral judgment sequence (see Table 1). There are problems, however, with such scalogram analysis. Though the simplex scale will demonstrate that events occur in a given sequence, the technique is not designed to account for transitional events. Thus, the scale cannot account for decalage, which must either be treated as error or ignored (Elliot, 1976). Despite the limits of Guttman scaling, attempts have recently been made to reconcile Piagetian and psychometic approaches (see Mogdil, 1974 for a review). Most ambitious are attempts to employ Rasch scaling (Elliot, 1974, 1975, 1976; Pearson, 1975) as a means of assessing the spread of abilities (decalage within a stage), as well as measuring movement to advanced levels with a series of subscales.

Controversies regarding the validity of Piaget's theory notwithstanding there has been a trend in recent years to seriously examine the relationships between the Piagetian view of cognitive development and the process of educational growth. Assumptions regarding the potential for such a relationship stem from (a) interpretations of development in the Piagetian sense as an educational aim in itself; thus equating cognitive-development (which includes social cognition, e.g., moral development) with educational growth; (b) the

notion that certain forms of academic content can only be fully understood when the appropriate cognitive structures have been developed, and (c) that the rate of stage change cannot be increased beyond certain limits. Taken together, points (b) and (c) suggest that the process of cognitive development places constraints upon educational growth.

The relationship between the attainment of concrete operations and educational success has been estimated both for school readiness, as well as the attainment of reading and math skills in elementary school. Piagetian measures appear to be good indices of school readiness. Scott (1969) found that kindergarten children's (n = 356) reasoning level as measured by a simple seriation task correlated .69 with scores on the Metropolitan Readiness Test for Arithmetic and .82 with scores for reading readiness. Most interesting is the finding that the seriation task measure proved to be a better predictor of later reading achievement than did the standardized readiness test. Kaufman & Kaufman (1972) reported that kindergarten children's scores on a battery of Piagetian tasks correlated .60 with first grade reading achievement and .64 with arithmetic achievement. Again the Piagetian measure had greater predictive validity than standard readiness measures. Findings for studies investigating the relationship between cognitive level and reading achievement in school-age children are summarized in Table 2. The findings

---
Insert Table 2 about here
---

show a low or moderate correlation between operative level and reading achievement. Worth noting is the variance in size of correlation depending upon the cognitive task employed. A general trend in the data suggests that the development of class inclusion (knowing that members of one class, e.g., cows are also members of a larger class, i.e, animals) and ordinal relations

(placing things in order along a single dimension, e.g., short to long) is more aligned with reading ability than is the ability to conserve amount (knowing that changes in shape do not change amount). This trend if supported by future research would indicate that aspects of a given level of development operate independently with regard to academic skill attainment rather than as a coordinated structure. Similar moderate correlations are reported in studies investigating operative level and math achievement (see Table 2). In sum, the correlations between traditional measures of academic achievement and cognitive development among grade school-age children suggest a modest relationship between the two variables.

One factor reducing the size of the correlations is the small age range among subjects within each of the reported studies. Because of this, the possibility exists that the variance in scores of operative thinking among subjects would be quite low thus reducing the overall correlation with measures estimating more refined quantitative differences in performance. This hypothesis is weakened, however, by findings (Neimark, 1975) relating scores on standardized achievement tests with the attainment of formal reasoning ability. Findings from several studies (Chiapetta, 1976; Kuhn, et.al, 1977; Shayer et. al, 1976) demonstrated that the spread among adolescent subject scores for the attainment of formal thought is quite high. Nonetheless, Neimark (1975) reports correlations between formal reasoning ability and math and science achievement of about the same magnitude (r .31-.40 for significant correlations) as those found with younger children (see Table 3).

Insert Table 3 about here

Perhaps the best explanation for these moderate correlations comes from factor analyses (DeVries, 1974) indicating that Piagetian measures of knowledge and standard psychometric measures (IQ and achievement tests) overlap

to some degree, but also measure different aspects of cognitive functioning. Piagetian theory makes a distinction between factual content which can be acquired through learning, and the actively constructed forms of logic which interrelate one's store of facts. Standard psychometric tests are heavily saturated with such content, since one function of schooling is to assess students' acquisition of culturally valued information (e.g., rules of grammar, vocabulary, scientific "facts", etc.). In addition, even those aspects of such tests which are interrelated with logic (i.e. math skills) may well be estimating student's ability to apply memorized procedures, rather than students' understanding of the problems or their solution. From this point of view then, standard means of assessment play an important role in measuring students' acquisition of culturally valued facts and skills, but provide only a rough estimate of their cognitive level.

Consistent with this interpretation are findings from studies (Collis, 1973; Griffiths, 1975; Herron, 1975; Lawson, 1974) which have demonstrated more powerful relationships between cognitive level and school related competencies when the achievement variable was defined in terms of problem solving ability rather than content familiarity. As an example, Griffiths (1975) found that college students' familiarity with physics content had no relationship to their ability to solve a classic physics problem, while the capacity for formal reasoning appeared to be a requisite for success with the task. Interestingly, Griffiths reports that a number of those subjects with formal reasoning, and capacity to master the physics problem were not admitted to a four year college because of their low scores on standard achievement tests. While such low scores might well have bearing on other aspects of the skills necessary for success in college, a clear implication of these results is that current measures of educational growth are not adequate measures of students' cognitive level.

Attempts at Reconciliation

In recent years there have emerged a number of attempts (Case, 1978a, Cellerier, 1972; Pascual-Leone, 1970; Scandura, 1977; Siegler, 1976; Simon, 1972) to bridge the differences between incremental growth models and Piagetian stage theory. This development has stemmed on the one hand from an awareness of the inadequacy of traditional (S-R) learning theory as an account of the sorts of cognitive changes defined by Piaget, and a dissatisfaction on the other hand with the perceived imprecision of Piaget's macroscopic analysis of cognitive structure and his description of stage change.

In the educational arena, these approaches were foreshadowed by Gagne's (1977) description of a cumulative learning hierarchy in which S-R associations are viewed as the basis for later more complex forms of learning (i.e., concept formulation; problem solving). Gagne accounts for the changes in cognitive capacity described by Piaget in terms of the progressive acquisition of super-ordinate concepts, rules, and skills. To account for the emergence of novel solutions, and conceptual abstractions, Gagne (1977) has included the possibility that movement from basic S-R learning to higher order processes may occur through self initiated cognitive activity. However, he does not make clear how such self initiated inductive and deductive processes can be accounted for in terms of S-R histories. Thus, Gagne's attempt to accomodate S-R theory to structuralism has been rigorously criticized (Achenbach, 1976; Scandura, 1973) as internally contradictory and unparsimonious.

In contrast with Gagne, most recent approaches to a fine grained analysis of cognitive growth have accepted two of Piaget's central notions as the starting point of their examination. First, the learner is viewed as actively processing information, rather than passively acquiring it. Second, the S-R bond has been replaced by the cognitive scheme (or its equivalent, e.g.,

"rule", Scandura, 1973) as the basic unit of learning. These accomodations with cognitive theory are not confined to models of intellectual growth but are evidenced in contemporary social learning theory's (Aronfreed, 1976; Bandura, 1976; Mischel, 1976) shift away from its earlier mediation theory stance to its current alignment with cognitive information processing, and attribution theories (see Gordon, 1978, for a more thorough discussion).

Though each of the moves toward accomodating incremental and cognitive developmental theories is distinct, a clear sense of the general form taken by these approaches can be illustrated with brief reference to two models which make direct claims of educational applicability: structural behaviorism (Scandura, 1973a and b, 1976, 1977), and the neo-Piagetian approach (Case, 1972, 1974, 1975, 1978a and b; Pascual-Leone, 1970).

In both structural behaviorism (Scandura, 1977) and the neo-Piagetian model (Case, 1978a) there is an acceptance of the basic sequence of stages outlined by Piaget as the framework for defining the general course of cognitive growth. However, both Case and Scandura (like other contemporary cognitive theorists) have attempted to add precision to Piaget's description. In Case's (1978a) model this is achieved by defining the stages in terms of groups of executive strategies that can be modeled by computer simulation rather than in terms of symbolic logic. These executive strategies serve to coordinate the operations, or cognitive sub-processes involved in the solution of specific problems. Scandura's description of cognitive structure is quite similar to Case's. However, where Case defines cognitive structure in terms of executive strategies and sub-operations, Scandura (1977) talks of relational networks or sets of higher and lower order rules (cognitive processes) which comprise the cognitive structures for a given content domain.

Despite these subtle differences in descriptive language both structural behaviorism and the neo-Piagetian model employ similar procedures to move from global descriptions of over-all cognitive organization to microanalyses of the rules or operations skilled members of a given population employ to solve specific problems (e.g. long division, subtraction, class inclusion, etc.) The method as described by Case (1978b) contains elements from both artificial intelligence research (e.g. Klahr and Wallace, 1976; Simon, 1972) and Piaget's (1960) clinical method. Briefly, the technique combines observation, logical analysis, and experimentation to arrive at a description of the general strategy individuals use to solve a given problem. Once this general strategy has been determined, a detailed analysis of the operations needed to execute each step of the strategy is conducted. The resulting algorithm may then be refined by reading each step in the procedure to an adult who is asked to carry out each operation. If a given procedure results in behavior not observed in the target skilled population, that aspect of the algorithm is modified. By employing variants of this procedure Case (1975, 1978b) and Scandura (1977) claim to be able to identify the nature of shifts in cognitive ability or skill acquisition involved in the mastery of sequences of increasingly complex problems.

In addition to analyzing the progression of strategies or rules employed in comprehending increasingly complex content, any serious attempt to bridge the gap between incremental and Piagetian growth models has to account for the saltatory changes in cognitive capacity associated with Piagetian stage change. Nearly all contemporary models of cognitive growth (e.g. Case, 1978a; Farnham-Diggory, 1972; Klahr and Wallace, 1976; Pascual-Leone, 1970; Scandura, 1977) explain these shifts in cognitive ability in terms of an interrelationship between the complexity of the rules available to the learner and the pro-

cessing capaciy of the individual. This notion (included in structural-behaviorism) is most clearly articulated in the neo-Piagetian models (c.f. Pascual-Leone, 1970; Case, 1978a) in which the general level of "operativity" considered by Piaget to represent the underlying capacity associated with each developmental stage is redefined in terms of quantifiable levels (units) of working memory. Within the neo-Piagetian framework the limits in cognitive capacity associated with younger children are explained in terms of restrictions in the complexity of cognitive strategies imposed by the number of available units of working memory. Development according to Case (1978a) can be seen as a process of increasing one's units of working memory. Within the model, working memory increases from a biologically determined "functional memory" capacity as a product of the construction and use of increasingly more complex executive strategies. This development occurs progressively as the operations of a given sub-stage are assembled in working memory out of components of the previous stage, Once these new operations become automatized (out of general experience) they add to the capacity of working memory. This increase in memory capacity in turn allows for the construction of more sophisticated executive strategies.

The teaching implications of structural behaviorism and neo-Piagetian theory are being explored (Case, 1975, 1978b; Scandura, 1973, 1976). However, because of space limitations, they won't be discussed here (see Case's chapter in this volume for a review of neo-Piagetian instructional techniques). Nonetheless, we wish to underline several important features of these two contemporary approaches which make them attractive as models of educational growth. First, these models move toward a methodology which permits educators to integrate the step-wise shifts in learner-strategy associated with learning culturally defined cognitive skills (e.g. the rules of long division) with the series of step-wise changes in learner strategies (cognitive processes) which mark the transition from one level of development to the

next. Further, Scandura (1977) has provided a cogent argument that even the construction of general logical abilities is a function of experience within a given content domain. That is, the rules one has available to execute higher order rules or executive strategies can be effected only if one has the sub-rules or strategies particular to a given content domain. Thus the prospect exists that one can begin to explain and predict decalage (stage mixture) as the absence of rules or strategies needed to permit the generalization of previously learned procedures to a novel content domain.

With the approach to defining cognitive growth offered by these two models one can begin to order educational tasks in a non-arbitrary hierarchy as function of the position of the task in a particular skill algorithm, and the position of that alogrithm relative to superordinate rules or executive strategies. The ordering of tasks is not only along a vertical difficulty dimension, but also along a horizontal content domain dimension. The precision with which task difficulty and corresponding learner capacity can be assessed is further enhanced by the inclusion of a quantitative measure of underlying cognitive capacity (unit(s) of working memory) which establishes the general parameters of the complexity of strategies available to the learner.

Evidence that the sort of analysis just described can be translated into practical assessment techniques has been provided in a series of studies conducted by Scandura (1977) and his associates. Their general procedure has been to identify the algorithms which represent the sequence of rules employed by skilled members of a target population to solve a given set of problems. The algorithms were then used to partial out the problems into tasks of equivalent difficulty. An experimental group was then tested with two items from each of the equivalence classes. Performance on one item from each equivalence

class was used to predict success or failure on the second item. The rationale behind this procedure was that the presence or absence of a given rule set should relate directly to success or failure on problems of a given type. Conversely, success or failure on an item of a given type should be evidence of the presence of absence of the rule. In this fashion overt behavior on an objective test should provide an accurate measure of the learner's possession or absence of specific rules or strategies which can be precisely located in an educational growth sequence. When such testing was done under ordinary classroom conditions, the predictions were accurate in about 84% of the cases (Durnin & Scandura, 1973).

It is a great leap to go from results of this sort to construction of assessment devices that can reliably and accurately index an individual's position on a growth function. However, the prospect that one can generate a sequence of test items that corresponds to a meaningful skill dimension integrated with a non-arbitrarily designated course of cognitive development is an exciting prospect. Such a procedure has clear advantages over simplistic applications of Rasch scaling in which the studied absence of theoretical assumptions about what one is measuring can lead to the ranking of tasks along trivial dimensions. However, cojoining Rasch scaling with the sort of analytic procedures offered by neo-Piagetian and structural behaviorist models may prove to be a formidable approach with which to define educational growth.

Though the models accomodating Piagetian and incremental views of cognitive growth offer education a set of new and exciting prospects, some words of caution are in order. Flavell (1978) has remarked regarding Case's work, that it has yet to be demonstrated that the units of working memory can be reliably defined. Without such reliability the utility of that aspect of the model is lost. In the same vein one can reasonably ask whether the definition of operativity in terms of units of working memory constitutes an over-simpli-

fication of stage change by focusing upon one outcome (memory capacity) resulting from increases in the flexibility of thought associated with progressive transformations in cognitive structure.

A second problem faced by neo-Piagetian and structural behaviorist accounts of cognitive growth is that the number of alogrithms and their potential interrelations needed to account for a complete micro-analysis of cognitive growth is staggering. Related to the problem posed by the sheer number of processes to be described is the probability that the algorithms defined will not accurately reflect the reasoning of all individuals. That is, while one can define a procedure sufficient to solve a given problem and perhaps even hit upon an approach used by many individuals, a given algorithm does not constitute a necessary approach to solving a given problem. Thus, one cannot assume that the steps outlined in one's analysis will necessarily hold for a given individual's approach to solving specific problems. In response to such issues, Scandura (1977) and other similar theorists (e.g. Case, 1975, 1978b; Klahr and Wallace, 1976; Siegler, 1975, 1978) present the view that within the bounds of a given content domain there are in practice a finite number of ways in which a given population will solve problems and that these procedures can be defined with sufficient precision to match the needs of the normal members of the population.

The issues raised regarding the number and form of the algorithms needed to accurately account for cognitive growth touch on the central problem area for attempts to cojoin incremental and cognitive developmental theories. As we alluded to before, Piaget (1963) makes a distinction between knowledge (facts or procedures) which can be acquired through direct instruction, and the process of logic underlying comprehension of those procedures. From a Piagetian perspective, the emergence of logical operations is a function of the individual's construction of knowledge out of the person's actions on the

environment. The precise steps involved in the construction of knowledge are hence postulated as unique to each individual. From the cognitive developmental stance the psychologist can outline the procedures which emerge at sub-stages representing points at which these individual constructions eventuate in common general strategies. In addition, one can outline in algorithmic form the culturally variable problem solving strategies (e.g. procedures for adding columns of numbers) which depend upon certain minimal logical competencies represented by a given sub-stage. However, one cannot hope to apply a common algorithm to represent the paths which individuals take to reach those developmental plateaus. The differentiation between what can be instructed and that which must be constructed has never been clearly made in any of the existing attempts to link incremental and stage theories. However, such a differentiation is necessary if we hope to delineate general trans-individual patterns of educational growth which can be defined and measured with general procedures from the idiographic shifts in cognitive strategy inherent in the individual's construction of knowledge.

Summary and Conclusions

In this chapter we have examined a number of psychological models of intellectual and affective development relevant to the definition of educational growth. Each of the approaches has strengths and weaknesses as models of educational growth stemming from the aspects they emphasize. As can be seen in Table 4 (constructed by the authors), psychometric approaches by emphasizing measurement, information acquisition, and continuity, provide excellent means

---

Insert Table 4 about here

---

of assessing incremental changes in fact acquisition. However, the relative

lack of emphasis on qualitative changes in cognitive functioning make them less useful than cognitive-developmental approaches for the assessment of transformations in students' ways of thinking. In addition, the cognitive-developmental approaches offer a set of absolute rather than normative measures of growth; thus increasing their utility. On the other hand, current cognitive-developmental approaches by not emphasizing measurement of the changes taking place between stages reduce their power as general models of growth. Recent approaches to cognitive growth (as illustrated by the neo-Piagetian and structural behaviorist models) offer the prospect of combining several of the best features of both the psychometric and cognitive-developmental approaches. As we saw earlier in the chapter, advances in statistical analysis (Bock, 1975; Rasch, 1966) open up the possibility that such a combination of cognitive-developmental and psychometric approaches can be achieved.

Even the marriage of psychometrics and cognitive stage theory, however, cannot compensate for the historical lack of emphasis on affective growth in those models. At the present time there is no other approach which incorporates the richness of description of affective growth offered by the psychoanalytic models. Unfortunately, the lack of emphasis on measurement and coynitive development make psychoanalytic approaches poor candidates as models of educational growth. Thus, there is a need for future research emphasizing the interaction between cognitive and affective growth processes if we are to develop a complete model of educational growth. Current trends in research on social cognition (see Gordon's chapter, this volume) offer promise in this regard.

Figure 1

Cross-Sectional Vocabulary Growth
(from Smith, 1941)

FITTED CURVES

TOTAL VOCABULARY

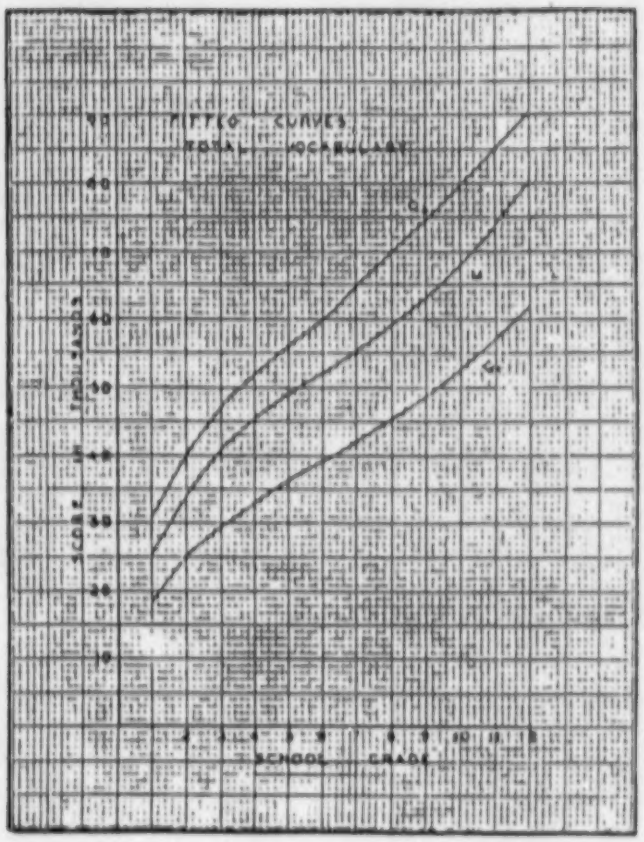


Figure 2

Cross-Sectional Binet Intelligence Growth
(from Thurstone, 1929)

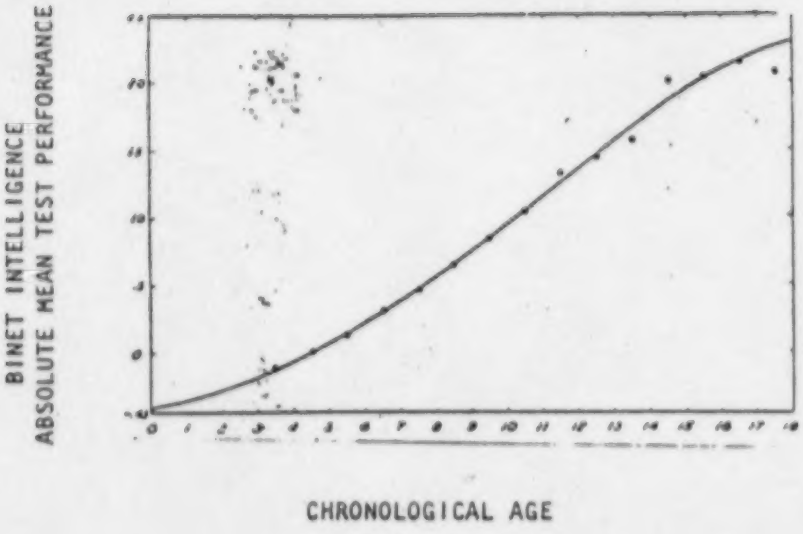
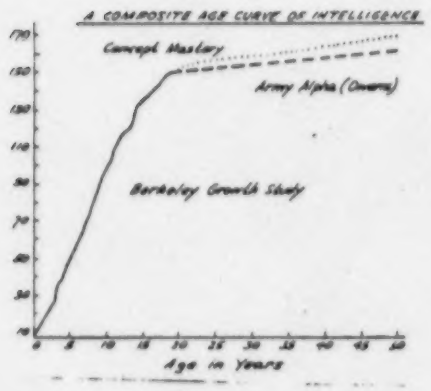


Figure 3

A proposed age curve of intelligence, birth to 50 years.
Based on data from the Berkeley Growth Study,
the Terman Gifted Study and Owen's Iowa Study. (After Bayley.[1])

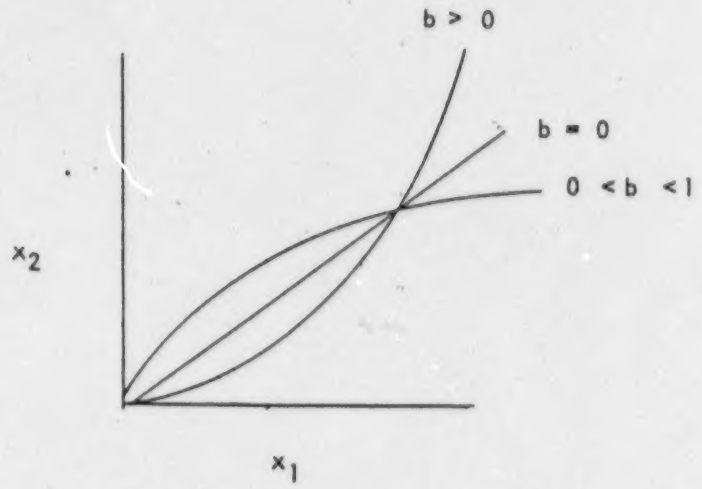
A COMPOSITE AGE CURVE OF INTELLIGENCE



AGE IN YEARS

Figure 4

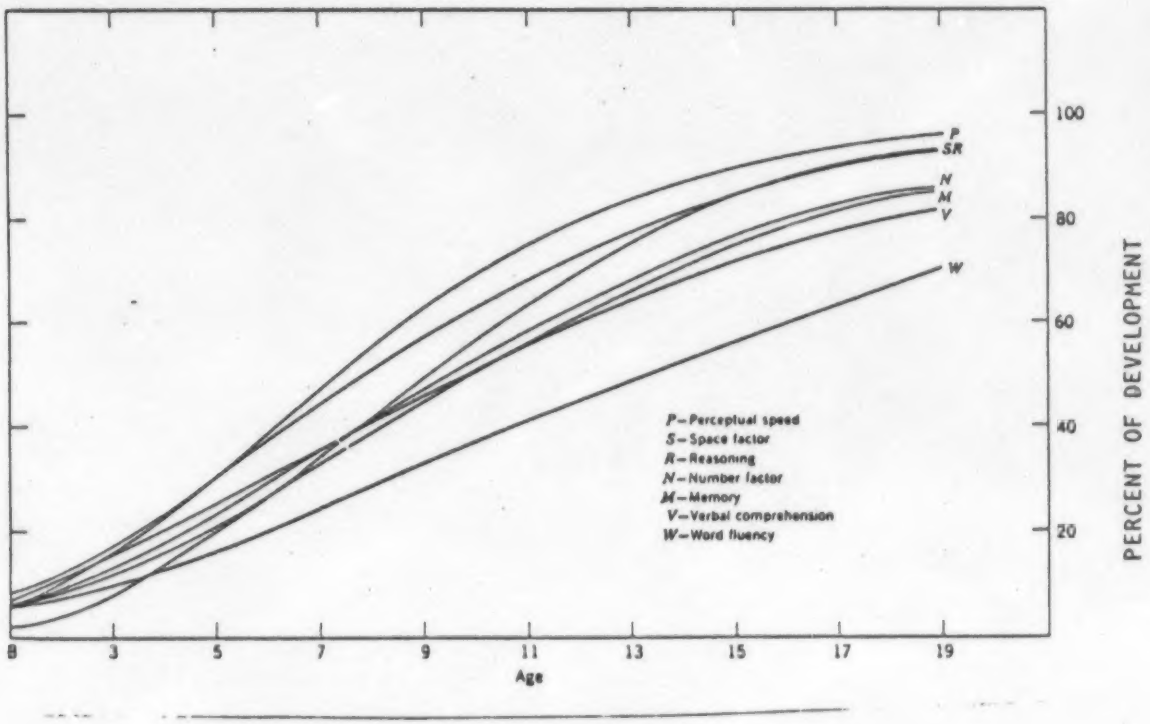
Allometric Curves for Two Measures



Note: The allometric equation is $x_2 = ax_1^b$ where x_1 and x_2 are measures of two parts of the same organism taken at various times and a and b are estimated constants from the regression $\ln x_2 = \ln a + b \ln x_1$. When $b = 0$, the growth rates of the two parts are equal; at all other values of b, the parts grow at different rates.

Figure 5

Estimated Curves for the Development of Specific Mental Abilities (Thurstone, 1955).



P - Perceptual speed
S - Space factor
R - Reasoning
N - Number factor
M - Memory
V - Verbal comprehension
W - Word fluency

Table 1

Stages of Development-Defined by
Havighurst, Freud, Erikson, Piaget and Kohlberg

	Functionalist	Psychoanalytic		Cognitive-Developmental	
		Theorist			
Approximate Ages	Havighurst (1964) Stages of Vocational Dev't	Erikson (1950) (Ego Stages)	Freud (1953) (Psychosexual Stages)	Piaget (1970) (Cognitive Dev't)	Kohlberg (1975) (Moral Dev't)
0 - 2 yrs		Trust vs. Mistrust	Oral Stage	Sensori-Motor	
2 - 4		Autonomy vs. Doubt	Anal Stage	Pre-Operational Stage Pre-Conceptual phase	
4 - 6	Identification with a Worker	Initiative vs. Guilt	Phallic Stage	Intuitive phase	Level I Pre-Conventional Stage 1 - Heteronomous Morality
10	Acquiring the Basic Habits of Industry	Industry vs. Inferiority	Latency Period	Concrete Operations	Stage 2 - Instrumental Hedonistic Morality
12		Identity vs. Role Confusion	Genital Stage	Formal Operations	Level II Conventional Stage 3 - Interpersonal Concordance "Good Boy" Morality
15	Acquiring Identity as a Worker		↓	↓	
18 - 25		Intimacy vs. Isolation	To Adulthood	To Adulthood	Stage 4 - Social System and Law and Order Morality
Adulthood	Becoming a Productive Person	Generativity vs. Stagnation			Level III Post-Conventional Principled Stage 5 - Social-Contract Morality
Old Age		Integrity vs. Despair			

I 41

Table 2

Correlation Between Developmental Level Assessed with Concrete Operations Tasks and School Achievement

Reading Achievement

Source	Piagetian Task	N	Achievement Measure	r.
Almy et. al (1966)	Conservation	37 (Kindergt.) 23 (Kindergt.) 38 (7 yr. olds) 22 (7 yr. olds)	Stanford Achievement	.53 .38 .37 .39
DeVries (1974)	Cons. Liquid Cons. Mass Cons. Number Class Inclusion Cons. Length Seriation	122 (5-7 yr. olds & low IQ children 6-12 yr. olds with MA 5-7 yr.)	MAT - Reading	.07 .20 .09 .24 .02 .22
	Seriation		MAT - Word Discrimination	.35
Kaufman & Kaufman (1972)	Piaget Battery	80 (Kindergt.)	Stanford Achievement at First Grade	.60
Lunzer et. al (1976)	Conservation Operativity	210 (6-7 yr. olds) 210	Schonell (Graded Word)	.31 .57
	Conservation Operativity	210 210	Neal (Analytic Reading Comp.)	.17 .38
Orpet et. al (1976)	Conservation of Liquid	52	Stanford Achievement	.13

Math Achievement

DeVries (1974)	Cons. Mass Cons. Number Class Inclusion Cons. Liquid Cons. Length Seriation	122 (5-7 yr. olds & low IQ children 6-12 yr. olds with MA 5-7 yr.)	MAT, Arithmetic Sub-Test	.20 .21 .41 .33 .02 .22
Dodwell (1961)	Conservation	34 (Kindergt.)	Arithmetic Test Constructed by E.	.59
Kaufman & Kaufman (1972)	Piaget Battery	80 (Kindergt.)	Stanford Achievement at First Grade	.64
Lunzer & Dolan (1976)	Conservation Operativity	210 (6.7-7 yr. olds)	Math Test Constructed by E.	.48 .71

Table 3
(Adapted from Neimark, 1975)

Correlations Between Reasoning Level Assessed
with Formal Operations Tasks and Stanford Achievement Test Scores (N=86)

Piagetian Task	Language	Arithmetic Concept	Arithmetic Application	Science
Combination 1	.13	.24	.25	.17
Combination 2	.20	.27	.31*	.16
Permutation 1	.22	.31*	.31*	.19
Permutation 1, IMC	.22	.30	.38	.28
Permutation 2	.18	.40*	.34*	.29
Permutation 2, IMC	.20	.24	.35*	.31*
Correlations: probability notions	.23	.25	.28	.38*

* .05 Level of Significance

Table 4

Comparison of Aspects Emphasized in
Psychological Models of Educational Growth

	Aspects								
owth Models	Genetic Determinants	Continuity	Qualitative Transformation	Acquisition of Information	Cognition	Affect	Theory	Measurement	Absolute Criteria of Growt
sychometric	2	4	1	4	2	1	1	4	1
sychoanalytic									
Freud	4	1	4	1	1	4	4	1	4
Erikson	3	2	4	2	2	4	4	2	3
nctional/Descriptive									
Gesell	4	1	3	1	1	2	1	3	3
Havighurst	2	2	3	3	1	3	1	1	2
gnitive-Developmental									
Piaget	2	2	4	2	4	1	4	2	4
Kohlberg	2	2	4	2	4	2	4	2	4
erarchical Behaviorism									
Gagne	1	3	3	4	2	1	2	3	2
havioral Structuralism									
Scandura	1	3	3	4	3	1	4	4	3
o-Piagetian									
Case	2	3	3	3	4	1	4	3	4

Little Emphasis
Moderate Emphasis
Strong Emphasis
Very Strong Emphasis

References

Achenbach, T. Research in Developmental Psychology: Concepts, Strategies, Methods. New York: The Free Press, 1978.

Almy, M., Crittenden, E., & Miller, P. Young Children's Thinking. New York: Teacher's College Press, 1966.

Ames, L. B., & Ilg, F. L. Gesell behavior tests as predictive of later grade placement. Perceptual and Motor Skills, 1964, 19, 719-722.

Anastasi, A. Psychological Testing. New York: MacMillan, 1976.

Aronfreed, J. Moral development from the standpoint of a general psychological theory. In T. Lickona (Ed.) Moral Development and Behavior. New York: Holt, Rinehart & Winston, 1976.

Bandura, A. Social Learning Theory. Englewood Cliffs, N. J. Prentice-Hall, 1977.

Barglow, P. The fate of the feminine self in normative adolescent regression. Paper presented at the Second Annual Central States Conference - American Society for Adolescent Psychiatry Meetings, Dallas, Texas, 1977.

Bart, W. M. The factor structure of formal operations. British Journal of Educational Psychology, 1971, 41, 70-77.

Batschelet, E. Introduction to mathematics for life scientists. New York: Springer-Verlag, 1976.

Bayley, N. Development of mental abilities. In P. H. Mussen (Ed.), Charmichael's Manual of Child Psychology. New York: John Wiley & Sons, 1970.

Bettelheim, B. The social-studies teacher and the emotional needs of adolescents. School Review, 1948, 56, 585-592.

Binet, A., & Simon, T. The development of intelligence in children. Baltimore: Williams and Wilkens, 1916.

Blum, G. S. A study of the psychoanalytic theory of psychosexual development. Genetic Psychology Monographs, 1949, 39, 3-99.

Bock, R. D. Basic issues in the measurement of change. Unpublished manuscript, University of Chicago, 1975.

Bovet, M. Cognitive processes among illiterate children and adults. In J. W. Berry & P. R. Dasen (Eds.), Culture and Cognition, London: Methusen, 1974.

Broughton, J. The development of natural epistemology in adolescence and early adulthood. Unpublished doctoral dissertation, Harvard University, 1975.

Brown, G. & Desfarges, C. Piagetian psychology and education: time for revision. British Journal of Educational Psychology, 1977, 47, 7-17.

Case, R. Learning and development: A neo-Piagetian interpretation. Human Development, 1972, 15, 339-358.

Case, R. Structures and strictures, some functional limitations on the course of cognitive growth. Cognitive Psychology, 1974, 6, 544-573.

Case, R. Gearing the demands of instruction to the developmental capacities of the learner. Review of Educational Research, 1975, 45, 59-87.

Case, R. Intellectual development from birth to adulthood: A neo-Piagetian interpretation. In R. Siegler (Ed.), Children's Thinking: What Develops? Hillsdale, N.J.: Lawrence Erlbaum Associates, 1978 (a).

Case, R. A developmentally based theory and technology of instruction. Review of Educational Research, 1978, 48, 439-463 (b).

Cellerier, G. Information processing tendencies in recent experiments in cognitive learning - theoretical implication. In S. Farnham-Diggory (Ed.) Information Processing in Children. New York, Academic Press, 1972.

Chiapetta, E.L. A review of Piagetian studies relevant to science instruction at the secondary and college level. Science Education, 1976, 60, 253-261.

Ciaccio, N.V. A test of Erikson's theory of ego epigenesis. Developmental Psychology, 1971, 4, 306-311.

Collis, K.F. A study of children's ability to work with elementary mathematical systems. Australian Journal of Psychology, 1973, 25, 121-130.

Constantinople, A. An Eriksonian measure of personality development. Developmental Psychology, 1969, 1, 351-372.

Counsilman, J.E. The science of swimming. Englewood Cliffs, N.J.: Prentice-Hall, 1968.

Dale, E. Vocabulary measurement. Elementary English, 1965, 42, 895-948.

Dasen, P. Piagetian Psychology: Cross-Cultural Contributions. New York: Gardner Press, 1977.

Dewey, J. Sources of a science of education. New York: Liveright, 1938.

Dignan, M. Ego identity, maternal identification and adjustment in college women. Unpublished doctoral dissertation, Fordham University, 1963.

Dodwell, D. Children's understanding of number concepts: Characteristics of an individual and of a group test. Canadian Journal of Psychology, 1961, 15, 29-36.

Douvan, E., and Adelson, J. The Adolescent Experience. New York: Wiley, 1966.

Durnin, J. & Scandura, J. An algorithmic approach to assessing behavior potential: Comparison with item forms and hierarchical technologies. Journal of Educational Psychology, 1973, 65, 262-272.

Ekstein, R. & Motto, R. Psychoanalysis and education: Teachers teaching techniques and the curriculum. Reiss-David Clinic Bulletin, 1966, 3, 5-73.

Elliot, C. The British intelligence scale project: Phase 2. Journal of the Association of Educational Psychology, 1974, 3, 9-13.

Elliot, C. The British intelligence scale: final report before standardization, 1975-76. Paper presented to the Annual Conference of the British Psychological Society, Nottingham, 1975.

Elliot, C. The measurement of development. In V.P. Varma and P. Williams, (Eds.), Piaget, Psychology and Education. Itasca, Ill.: Peacock, 1976.

Erikson, E. Childhood and Society. New York: Norton, 1950.

Farnham-Diggory, S. The development of equivalence systems. In S. Farnham-Diggory (Ed.) Information Processing in Children. New York: Academic Press, 1972.

Freud, A. (1936) The Writings of Anna Freud, Vol. II. The Ego and the Mechanisms of Defense. New York: International Universities, 1966.

Freud, A. Adolescence as a developmental disturbance. In G. Caplan and A. Lebovici (Eds.), Adolescence: Psychosocial Perspectives. New York: Basic Books, 1969.

Freud, S. A General Introduction to Psychoanalysis. (Joan Riviere, trans.) New York: Permabooks, 1953.

Gagne, R. The Conditions of Learning. New York: Holt, Rinehart & Winston, 1977.

Gallatin, J.E. Adolescence and Individuality: A Conceptual Approach to Adolescent Psychology. New York: Harper & Row, 1975.

Gesell, A. The Mental Growth of the Preschool Child. New York: MacMillan, 1925.

Gesell, A. Infancy and Human Growth. New York: MacMillan, 1928.

Ginsburg, H. & Opper, S. Piaget's Theory of Intellectual Development. Englewood Cliffs, N.J.: Prentice-Hall, 1969.

Gordon, N.J. A review of Albert Bandura's Social Learning Theory. International Journal of Political Education, 1978, 1, 292-295.

Griffiths, D. Physics teaching, does it hinder development. American Journal of Physics, 1976, 44, 81-86.

Guttman, L. A generalized simplex for factor analysis and a facetted definition of intelligence. Psychometrika, 1955, 20, 173-192.

Haan, N. Coping and Defending. San Francisco: Academic Press, 1977.

Hartman, H. Ego Psychology and the Problem of Adaptation. New York: International Universities, 1939.

Havighurst, R. J. Developmental Tasks and Education. Chicago: University of Chicago Press, 1948.

Havighurst, R. J. Human Development and Education. New York: Longmans, 1953.

Havighurst, R. J. Youth in exploration and man emergent. In H. Borow (Ed.) Man in a World at Work. Boston: Houghton Mifflin, 1964.

Herron, J. D. Piaget for chemists. Journal of Chemical Education, 1975, 52, 146-150.

Ilg, F. L. & Ames, L. B. School Readiness. New York: Harper & Row, 1965.

Inhelder, B., Sinclair, H., & Bovet, M. Learning and the development of cognition. Cambridge, Mass.: Harvard University Press, 1974.

Kamii, C. & Derman, L. The Engleman approach to teaching logical thinking: Findings from the administration of some Piagetian tasks. In D. R. Green , M. P. Ford, & G. B. Flamer (Eds.), Measurement and Piaget. New York: McGraw-Hill, 1971.

Kaufman, A. & Kaufman, N. Tests built from Piaget's and Gesell's tasks as predictors of first grade achievement. Child Development, 1972, 43, 521-535.

Klahr, D. & Wallace, J. Cognitive Development: An Information Processing View. New York: John Wiley & Sons, 1976.

Kohlberg, L. Stage and sequence: the cognitive-developmental approach to socialization. D. A. Goslin (Ed.), Handbook of Socialization Theory and Research, Chicago: Rand McNally, 1969.

Kohlberg, L. Continuities in childhood and adult moral development revisited. In P. B. Baltes and K. W. Schaie (Eds.), Lifespan Developmental Psychology - Personality and Socialization. New York: Academic Press, 1973.

Kohlberg, L. Moral judgment scoring manual. Unpublished manuscript, Harvard University, 1975.

Kuhn, D. Mechanisms of change in the development of cognitive structures. Child Development, 1972, 43, 833-844.

Kuhn, D., Langer, J., Kohlberg, L., & Haan, W. The development of formal operations in logical and moral judgment. Genetic Psychology Monographs, 1977, 95, 97-188.

Lawson, A. E. Relationship of concrete and formal operational science subject matter and the developmental level of the learner. Paper presented at the National Association of Science Teaching Convention, April, 1974.

Lenneberg, E. Biological Foundations of Language. New York: Wiley, 1967.

Linn, R. L., & Slinde, J. A. The determination of the significance of change between pre-and posttesting periods. Review of Educational Research, 1977, 47, 121-150.

Loevinger, J. The meaning and measurement of ego development. American Psychologist, 1966, 21, 195-206.

Lorge, I., & Chall, J. Estimating the size of vocabularies of children and adults: An analysis of methodological issues. Journal of Experimental Education, 1963, 32, 147-157.

Lumsden, J. Test theory. Annual review of psychology: Volume 27. Palo Alto, California: Annual Reviews, 1976.

Lunzer, E., & Dolan, T. The effectiveness of measures of operativity, language, and short-term memory in the prediction of reading and mathematical understanding. British Journal of Educational Psychology, 1976, 46, 295-305.

Marcia, J. The development and validation of ego-identity status. Journal of Personality and Social Psychology, 1966, 3, 551-558.

Marcia, J. & Friedman, M. L. Ego identity status in college women. Journal of Personality, 1970, 38, 249-263.

Marcia, J. E. Studies in ego identity. Unpublished Monograph, Simon Fraser University, 1975.

Marcia, J. E. Identity six years after: A follow-up study. Journal of Youth and Adolescence, 1976, 5, 145-160.

McLaughlin, B. Second Language learning in children. Psychological Bulletin, 1977, 84, 435-457.

Mischel, W., & Mischel, H. A cognitive social-learning approach to morality and self-regulation. In T. Lickona (Ed.), Moral Development and Behavior. New York; Holt,,Rinehart & Winston, 1976.

Mogdil, S. Piagetian Research: A Handbook of Recent Studies. Windsor: NFER, 1975.

Neimark, E. D. A preliminary search for formal operations structure. Journal of Genetic Psychology, 1970, 116, 223-232.

Neimark, E. D. Longitudinal development of formal operations thought. Genetic Psychology Monographs, 1975, 91, 171-225.

Nucci, L. Social development: personal conventional and moral conepts. Unpublished doctoral dissertation, University of California, Santa Cruz, 1977.

Nucci, L., & Turiel, E. Social interactions and the development of social concepts in preschool children. Child Development, 1978, 49, 400-407.

O'Connell, A. The relationship between life style and identity synthesis and resynthesis in traditional, neo-traditional, and non-traditional women. Journal of Personality, 1976, 44, 675-688.

Orlofsky, J. L., Marcia, J.E., Lesser, I. Ego identity status and the intimacy vs. isolation crisis of young adulthood. Journal of Personality and Social Psychology, 1973, 27, 211-219.

Orpet, R. E., Myers, L. & Grein, S. Relationship between performance on a Piagetian liquid conservation task and reading achievement in seven year old children. Educational and Psychological Measurement, 1976, 36, 1021-1024.

Pascual-Leone, J. A mathematical model for the transition rule in Piaget's developmental stages. Acta Psychologica, 1970, 32, 301-345.

Pearson, L. Developmental scales in the British intelligence scale. Paper presented to the Annual Conference of the British Psychological Society, Nottingham, 1975.

Piaget, J. (1928) The Child's Conception of the World. Patterson, N.J.: Littlefield, Adams and Company, 1960.

Piaget, J. (1937) The Origins of Intelligence in Children. New York: W. W. Norton, 1963.

Piaget, J. Six Psychological Studies. New York: Random House, 1968.

Piaget, J. Piaget's theory. In P. H. Mussen (Ed.) Carmichael's Manual of Child Psychology. New York: John Wiley and Sons, 1970.

Riegel, K.F. Influences of economic and political ideologies on the development of developmental psychology. Psychological Bulletin, 1972, 78, 129-141.

Scandura, J. Structural Learning I: Theory and Research. London: Gordon & Breach Science Publishers, 1973 (a).

Scandura, J. Structural Learning and the design of educational materials. Educational Technology, 1973, 13, 7-13 (b).

Scandura, J. A deterministic theory of learning and teaching. In H. Spada & W. F. Kempf (Eds.), Formalized Theories of Thinking and Learning and Their Implications for Science Instruction. Bern: Huber, 1976.

Scandura, J. Structural approach to instructional problems. American Psychologist, 1977, 32, 33-53.

Scott, R. Social class, race, seriating and reading readiness: A study of their relationship at the kindergarten level, The Journal of Genetic Psychology, 1969, 115, 86-96.

Shayer, M., Kuchemann, D., & Wylan, H. The distribution of Piagetian stages of thinking in British middle and secondary school children. British Journal of Educational Psychology, 1976, 46, 164-173.

Siegler, R. S. Issues in studying developmental change. In B. Blai & J. Kornfield (Eds.) Proceedings of the Sixth Annual Structural Learning Conference. Narbeth, Pa: Structural Learning Society & MERGE Research Institute, 1975.

Siegler, R. S. Three aspects of cognitive development. Cognitive Psychology, 1976, 8, 481-520.

Siegler, R.S., The origins of scientific reasoning. In R. S. Siegler (Ed.) Children's Thinking: What Develops? Hillsdale, N.J.: Lawrence Erlbaum Associates, 1978.

Simon, H. A. On the development of the processor. In S. Farnham-Diggory (Ed.), Information Processing in Children, New York: Academic Press, 1972.

Skinner, B. F. Are theories of learning necessary? Psychological Review, 1950, 57, 193-216.

Smedslund, J. The acquisition of conservation of substance and weight in children. Scandinavian Journal of Psychology, 1961, 2, 11-20.

Smith, M.K. Measurement of the size of general English vocabulary. General Psychological Monographs, 1941, 24, 311-45.

Snow, C.E. & Hoefnagle-Hohle, M. The critical period for language acquisition: Evidence from second language learning. Child Development, 1978, 49, 1114-1128.

Strauss, S. Inducing cognitive development and learning: A review of short term training experiments: The organismic approach. Cognition, 1972, 1, 329-357.

Strauss, S. A reply to Brainerd. Cognition, 1973, 3, 155-185.

Strauss, S., & Liberman, D. The empirical violation of conservation laws and its relation to structural change. Journal of Experimental Child Psychology, 1974, 18, 464-479.

Strauss, S., Danziger, J. & Ramati, T. University students' understanding of non-conservation: Implications for structural reversion. Developmental Psychology, 1977, 13, 359-363.

Thurstone, L.L. The absolute zero in intelligence measurement. Psychological Review, 1928, 35, 175-197.

Turiel, E. An experimental test of the sequentiality of developmental stages in the child's moral development. Journal of Personality and Social Psychology, 1966, 3, 611-618.

Turiel, E. Conflict and transition in adolescent moral development. Child Development, 1974, 45, 14-29.

Turiel, E. The development of social concepts: Mores, customs, and conventions. In D.J. DePalma and J.M. Foley (Eds.), Moral Development: Current Theory and Research. Hillsdale, N.J. Erlbaum Associates, 1975.

Turiel, E. The development of concepts of social structure: social convention. In J. Glick and A. Clarke-Stewart (Eds.) The Development of Social Understanding. New York: Gardner Press, 1978.

Turiel, E. Distinct conceptual and developmental domains: Social convention and morality. Nebraska Symposium on Movitation, 1977 (Vol. 25) Lincoln: University of Nebraska Press, 1979.

von Bertalanffy, L. General systems analysis. New York: Basic Books, 1968.

Walberg, H.J. Psychological theories of educational individualization. In H. Talmage (Ed.), Systems of individualized education. Chicago and Berkeley: National Society for the Study of Education and McCutchan Publishing, 1975.

Walberg, H.J., Keiko, H. & Rasher, S. English acquisition as a diminishing function of experience rather than age. Tesol Quarterly, 1978, 12, 427-437.

Waterman, A., & Goldman, J. A longitudinal study of ego identity developmental at a liberal arts college. Journal of Youth and Adolescence, 1976, 5, 361-369.

Wright, B.D. Solving measurement problems with the Rasch model, Journal of Educational Measurement, 1977, 14, 80-95.